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# Decrements in Olfactory Sensitivity Due to Ozone Exposure

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# DECREMENTS IN OLFACTORY SENSITIVITY DUE TO OZONE EXPOSURE

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*Summary.*—Approximate olfactory thresholds were determined in an exploratory study in which subjects were exposed to ozone ($O_3$). The odorants were butyl alcohol (BA) and acetic acid (AA). Preliminary data suggest (1) temporary increases in thresholds due to $O_3$ exposure, (2) diminution of $O_3$ effects with repeated exposures, and (3) greater and more reliable effects for BA than for AA.

The nasal and olfactory epithelia are the first wet tissues to be contacted by inspired gases. There is reason to believe that a substantial amount of inspired ozone ($O_3$), a potent oxidant, is absorbed by these tissues (Brain, 1970). Kulle and Cooper (1975) found, in an acute experiment with rats, that $O_3$ alters the responsiveness of the nasopalatine nerve to amyl acetate. The location of the olfactory receptors in the olfactory epithelium makes the sense of smell vulnerable to the effects of $O_3$. For this reason olfactory sensitivity to odorants was hypothesized to be a good indicator of early $O_3$ effects. This paper reports the results of a preliminary experiment with human subjects.

For four consecutive days eight healthy young males were exposed to an atmosphere containing 0.4 ppm of $O_3$ for 4 hr. during which they exercised on a treadmill at 10% grade and a speed of 4 mph. for two 15-min. periods. This exercise was used to increase ventilation volume to enhance entry of $O_3$ into the airways. As a control, a day of exercise without $O_3$ preceded the 4 exposure days.

Olfactory thresholds were evaluated using the method of constant stimuli with geometrically diluted solutions in sniff bottles (Beck, Kruger, & Calabresi, 1954) before and after each day's exposure. The test substances were butyl alcohol (BA) and acetic acid (AA) diluted in deionized water. Ten presentations of each of seven stimulus dilutions were made for each odorant. Stimuli were presented every 15 sec. The results were expressed in terms of differences in percent of correct detections before and after $O_3$ exposure.

Fig. 1 illustrates the percent change of correct detections for each odorant on each of 5 days. The standard errors of these changes were computed by pooling over all 5 days and were 2.80 for BA and 3.72 for AA. An $n$ of 8 was used to compute the standard error since only eight independent subjects were tested on five repeated days.

Sensitivity to BA is decreased by $O_3$ exposure but on subsequent days the effect is attenuated, perhaps indicating adaptation to or recovery from the effects of $O_3$. A decrement occurred in AA sensitivity on the first $O_3$ day but the subjects' sensitivity appeared to return to normal or to increase after $O_3$ exposure on subsequent days. The AA data were more variable and therefore, the change is more difficult to evaluate in terms of differential odorant effects. A study of pre-exposure data indicated that on each day the

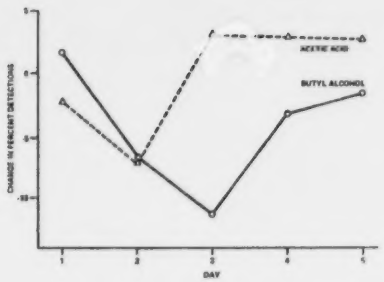


FIG. 1. Mean percent differences in olfactory sensitivity after $O_3$ exposure

subjects' sensitivity returned to normal by the next day's pre-exposure test, a period of about 18 hr. after the last $O_3$ exposure.

In this preliminary study there were not enough subjects to test the statistical significance of the results. Frequently, though, investigators have used repeated uncorrected *t* tests to test the significance of differences from control data. This illegitimate procedure would have shown both odorant thresholds to have been significantly increased on at least one day.

It is of interest to note that pulmonary functions (forced vital capacity, respiratory airway resistance, maximum ventilation volume, and maximum expiratory flow rate among others) measured on a larger group of subjects, of which the olfactory subjects were a subset, showed significant decrements due to $O_3$ exposure. More importantly, they showed the same pattern of daily recovery and gradual adaptation to $O_3$ (R. W. Stacy, personal communication, August 8, 1978). Should these results prove to be replicable, further studies will include inquiry into the time course and duration of the phenomenon, the effect on various odorants and the effect of nasal secretions.

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